

THE USE
OF THE
SEMICIRCLE

In taking
OF HEIGHTS, DEPTHS,
and DISTANCES:

AND
In SURVEYING
OF
LAND.

AND
How it may be made Serviceable
for other GOOD and USEFUL
PURPOSES.

LONDON,

Printed by *W. G.* for *Walter Hayes*
at the *Cross-Daggers* in *Moor-fields*,
where you may have all sorts of
Mathematical Instruments.





TO THE
Reader.

THe Instrument or Semi-circle hereafter described, and some of its Uses exemplified in the Longimetria or the Measuring of Heights and Distances; and also, and chiefly, in Planimetria, or the Measuring of Plains, as in Geodecia or the Measuring of Land; is not only confined to those Practices, but may be made serviceable.

To the Reader.

viceable also for many other good and useful purposes.

In Astronomy it is very commodious, and convenient, for Cœlestial Observations, especially for such as are made of the Moon and Stars, for by it (by help of the Ball-socket) the Distances of the Fixed Stars one from another, or of a Fixed Star from a Comet, the Moon or any of the other Planets may be very conveniently, and accurately observed, if the Instrument be but any wise conveniently handled.

For

To the Reader.

For the Describing of Countries, and for Large and Capacious Grounds, it is far more convenient than the Circumferentor, and much to be prized above the Geodetical Staff, or Topographical Glass of Mr. Arthur Hopton's Invention.

Again, for the designing or laying out of Ground for the Erection of large and stately Edifices, and for designing of Grounds for Quartering of an Army, and laying out of ground for a

To the Reader.

Fort for the defence of a place, this Instrument is inferior to none.

I might instance in other Particulars, as in Gunnery, Dialling, &c. but at present let this suffice. The chief Uses, to which I have in this following Treatise applyed it, I have reduced to these following heads.

I. By it I have taught how to take all manner of Heights whether accessible or inaccessible.

II. To

To the Reader.

II. To take all sorts of *Distances* whether *approachable* or not.

III. To take the *Distance* of several *Places* one from another, with great ease and facility, by which the most eminent *Places*, as *Churches*, *Towers*, *Steeples*, *Ports*, *Havens*, and all other things remarkable, may be laid down *in Plano*, according to their true *Symetry* or *Proportions*.

IV. I have discovered
A 5 how,

To the Reader.

how, by it, to take the true *Plat* of any field whatsoever, and that three several ways.

1. By taking your *Station* in, or about the *middle* of the field.

2. By taking your *Station* at one *corner* thereof. And

3. By going round about the same, and making a *Station* at every *Angle* thereof.

In all which wayes the manner of Protracting or laying
ing

To the Reader.

ing down a Plat of the same upon paper or parchment is also discovered, and to cast up the content or quantity of any such Piece so platter or protracted.

These Uses I have here briefly touched, having elsewhere more at large treated upon this Subject of Geodæcia in my Complete Surveyor, to which, for further satisfaction in that Art, I must refer the Reader, and at this time bid him, Farewel.

W. L.



ADVERTISEMENT.

IF any Gentleman studious in the *Mathematicks*, have, or shall have occasion for Instruments thereunto belonging, or Books to shew the Use of them, they may be furnished with all sorts useful both for Sea and Land, either in Silver, Brass, or Wood, by *Walter Hayes* at the *Cross-Daggers* in *Moor-Fields*, next dore to the *Popes-head* Tavern; where they may have all sorts of Maps, Globes, Sea-Plats, Carpenters Rules, Post and Pocket-Dialls for any Latitude.

11 JULY 63



A
DESCRIPTION
OF THE
SEMICIRCLE.

A *Semicircle in Geometry is thus defined, A Semicircle is the one half of a Circle cut off by the Diameter, and is contained under a right Line, which is the Diameter; and an Arch or crooked Line, which is the Circumference, Periphery or Limb.*

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The

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The *Semicircle* which we here intend to Describe and shew the Use of, is usually made in Brass, the *Diameter* whereof doth usually contain in length about 10 Inches, the *Semidiameter* half as much ; the *Diameter* and *Limb* are either of them about an Inch in breadth : The *Limb* of this *Semicircle* is divided into 180 equal parts, called *Degrees*, and every of those *Degrees* is usually divided into smaller equal parts, according to the bigness of the *Instrument* (usually into four) so is every small division a part, 15 *Minutes*. It is sometimes divided by *Diagonals*, so that you may (though the *Instrument* be small) take off every third or fourth *Minute*. These *Degrees* are numbered from

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From the left hand towards the right, by 10, 20, 30, &c, to 180; and back again from the right hand towards the left, by 190, 200, 210, &c. to 360.

Upon the *Centre* of this *Semicircle* is placed a round *Box* of *Brass*, in the bottom whereof is a *Card*, having upon it the 32 points of the *Mariners Compass*, and over it a *Needle* covered with *Glass*; this *Needle* is at any time to set the *Diameter* of the *Semicircle* due *North* and *South*, or according to any other *Coast*.

Between the *Semicircle* and this *Box* is an *Index*, which moves upon the *Centre* of the *Semicircle*, and is of sufficient length to cut at either end thereof the *Degrees* on the *Limb* of the *Semicircle*. It hath upon

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it two *Sights*, through which you may look either backward or forward, to any *Mark* or *Object*.

On the backside of the *Semicircle* is screwed a *socket*, into which goeth another *socket* called a *Ball-socket*, which serveth to set the *Semicircle* when it is upon the *Staff* in any position whatsoever, as *horizontal* or *level*, *vertical* or *perpendicular*, or *reclining*, or *inclining* to any *Angle*.

Into this *Ball-socket* there goes the head of a *three-legged-staff*, which supporteth the *Instrument* in the field.

These are all the parts of the *Semicircle*, as it is to be used in the fields to make *Observations*; but to lay down your
Work

Work at home, there belong-
eth,

1. *A Protractor.*
2. *A Scale.*
3. *A protracting Pin.*
4. *A pair of Compasses.*

1. The *Protractor* is made of a thin piece of Brass divided in all respects as the *Semicircle* was, and numbered in the same manner from 1 to 180 degrees, but from 180 degrees to 360 degrees; it ought to be numbered from the left hand towards the right, contrary to the numbering of your *Semicircle*. The use of this *Protractor* is to lay

B 3 down

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down the quantities of those
Angles upon *Velem* or *Paper*
which you observe in the field.

2. Your *Scale* is a Ruler of
Brass, upon which you may have
what Scales you please, either
plain or *diagonal*, as of 10, 11,
12, 16, 20, 24, 30 and 32 in an
Inch; these *Scales* are to lay
down the lengths of your Lines,
as you measured them in the
field with your Chain, and ac-
cording to the largeness or smal-
ness of your Scale, you may make
our Plat or Draught of what
bigness you please.

3. Your *Compasses* are to take
your distances from your Scale,
and to apply them to your paper
or velem.

4. Your

4. Your *protracting Pin* is to fix in your Centre point, and also to mark the degrees on the edge of your *Protractor*.

The *Chain* which you measure your lengths in the field, may be of what length and how you will divided, but the Chain which the Examples in this Book are wrought by, is 4 Pole in 100 Links.

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THE USE
of the
SEMICIRCLE

In taking
OF HEIGHTS, DEPTHS
and DISTANCES.

PROP. I.

*How to take the Height of
any Tree, Tower, Stee-
ple, or other Object which
standeth upright, and be-
ing accessible at one Stati-
on.*

FIG. I.

L Et A B be a *Castle-Wall*,
whose height you would
B 5 know,

know, you standing at C, place your Semicircle at G, and turning it about by help of your Ball socket, direct it to the Object, then fixing all your Sockets fast, by help of the screws for that purpose, hang a Thrid and Plummet upon the Centre of your Semicircle, and move the Semicircle up and down till the Thrid and Plummet hang directly upon 90 deg. then laying the Index just upon the Diameter, there hold it, and looking through the Sights, mark what part of the *Castle-Wall* you see, for that part is in the true level with your eye, which point let be D; then, the Index still remaining fixed, move the Semicircle upwards or downwards, till (through the sights) you see the

(FR)

the very top of the *Castle-Wall* at A (the Semicircle still remaining immoveable) look what number of degrees and parts the Thrid cutteth, which degrees let be 55, which you must set down; lastly, measure the distance from G to B, which let be 200 Foot, to which add 5 Foot, the height of your Semicircles Centre from the ground CE, and it makes 205 Foot; by help of this distance and the degrees before noted down, you may find the altitude of the *Castle-Wall*, as followeth.

Example.

Upon a piece of Velem or paper, draw a line at length as MN, towards one end whereof,

as

as at B, erect a perpendicular A B, representing the *Castle-Wall*; then from one of your *Scales* take with your *Compasses* 205 Foot, and set that distance upon your paper or velem, from B, the foot or bottom of the *Castle-Wall*, to C, so shall C upon your paper, represent the place on the ground where the *Semicircle* stood, and 5 Foot more being added (which is the height of your *Semicircle* from the ground) E C maketh 205 Foot, which taken from your *Scale* will reach from B to F.

This done, place the Centre of your *Protractor* upon the point F, and the Diameter thereof upon the line M-N, then count 35 degrees (which is so much as 55 deg. which the third cut

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cut, wants of 90 deg.) upon the edge of the Protractor, and against it make a *mark* or *point* with your *protracting Pin*, through which point (or mark) and the point F, draw the line F A, cutting the line A B, representing the Castle-Wall, in A, so shall A B be the height of the Wall, which being measured by the same Scale as B F 205 Foot was taken from, will be found to be 143 Foot, and so high is the Castle-wall from the ground.

PROP.

PROP. II.

*How to take the Height of
an Object which is not ac-
cessible at two Stations, by
help of the Semicircle.*

Suppose A B to be a Castle-Wall as before, and you cannot come nearer to the Wall than G, for that there is a Moat about the Wall so broad.

First, Place your Semicircle at G, the edge of the Moat or Trench, and directing the sights to A, the top of the Wall, you shall find the to Thrird cut 30 de.

Secondly,

Secondly, Go backwards a competent distance of ground, in a right line, as to F, and there placing your *Semicircle* as before, direct the sights to A, where you shall find the Thrid to cut 55 deg.

Thirdly, Measure the distance between G and F, which let be 125 Foot; these two Observations being made at G and F, and the distance between them measured by the Chain, the altitude of the Wall may be easily attained in manner following.

Example.

First, Upon paper, or the like, draw a line M N, upon which,
to-

towards one end thereof, as at F, place the Centre of your Protractor, and because the Thrid there cut 55 deg. make a mark against 35 deg. of your Protractor (which is so much as 55 deg. wants of 90 deg.) and through this point, and the point F, draw a right line at length upwards.

Secondly, For that the distance between G and F (your two stations) was 125 Foot, take 125 out of some one of your scales, and set off that distance upon your paper from F to G.

Thirdly, Lay the Centre of your Protractor upon G, and the Diameter thereof upon the line M.N., and because when you
made

made Observation at G, the
 Thrid cut 30 deg. make a mark
 against 60 deg. of the Protractor,
 (which is so much as 30 de. wants
 of 90 d.) and through this mark,
 and the point G, draw a right line
 at length upwards, continuing it
 till it cut the former line drawn
 from F, which it will do in the
 point A.

Lastly, From the point A let
 fall a perpendiclar upon the
 line M N, which will fall upon
 the point B, so is A B the height
 of the Castle-Wall, which if
 you take in your Compasses, and
 measure it upon the scale from
 whence you took your distance
 F G, you shall find it to contain
 143 Foot, and so high is the
 Castle-Wall.

PROP.

PROP. III.

A Fort or Castle being besieged, how the Besiegers shall know of what length to make Scaling-Ladders that shall reach from the edge of the Moat or Trench to the top of the Wall.

L Et A B be the Wall of a Fort or Castle, and that the Castle within were besieged, the Besiegers lying at F, and cannot come nearer to the Wall than G, the edge of the Moat; wherefore standing at G, make Observation with your Semicircle

cle as you did before, and you shall find the Thrid to cut 30 deg.— Do the like at F, and you shall find the Thrid to cut 55 deg. and the distance between G and F measured will be found to be 125— These two Observations being made, and the distance F G measured (all which are the same as in the last *Prop.*) you may protract or lay down the same upon velem or paper, in all respects as in the former *Prop.* and so measuring the line G A upon the same scale that G F was measured by, you shall find it to contain 166 Foot, and so long must Ladders be to scale the Walls of this Fort or Castle.

PROP.

PROP. IV.

Standing upon a Wall or Tower of a known height, to find how far any Ship, Tree, &c. is from you.

L Et A be the top of a Tower or Castle standing by the Sea side, and let F be a ship lying at anchor, and you would know how far that ship is off the Castle-Wall.

Standing upon the Tower-Wall at A, with your *Semicircle*, direct the sights (the Index lying upon the Diameter) to F, the Thrid will cut 55 deg. then the Castle-Wall being 143 Foot high;

high; by help of these two you may find the distance that the ship at F, is from the Castle-Wall B, in this manner.

Upon paper or parchment draw a line A B, representing the Castle-Wall, and upon it; by help of your scale, set the height thereof 143 Foot, from A to B, and upon the point B erect the perpendicular B F.

Then placing the Centre of your Protractor upon A, turn it about upon that point, till 55 deg. (which were the degrees cut by the Thrid) come to lie directly upon the line A B, then at 00 deg. (or the beginning of the Semicircle of the Protractor) make a mark close by the edge thereof, through which point and the point A, draw a line

line at length downwards, which line being drawn, will cut the line B F in the point F, so the distance B F, being taken in your Compasses, and measured upon the same scale from whence A B (the height of the Wall) was taken, it will be found to contain 205 Foot, and so far is the ship F from the Castle-Wall B.

PROP. V.

*How to take an inaccessible
Distance at two Stations
by the Semicircle.*

FIG. II.

Suppose you were standing
at G, and that it were re-
quired of you to know how far
distant the Tree of A is from
you, between which and you
there is the River D, so that
you cannot come near A.

First, Place your *semicircle*
at C, laying the Index on the
Diameter

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Diameter thereof, and turn the Semicircle about till through the sights you see the Tree at A, and there fixing the Semicircle, turn the Index about till you see the Mark set up at B, and there note what degrees the Index cutteth, which let be 110 deg.

Secondly, Remove your Semicircle from C to B (setting up a Mark at G, where your *Semicircle* before stood) and laying the Index on the Diameter thereof, turn the *Semicircle* about till through the sights thereof you see the Mark at C, where your Instrument before stood, and there fixing the *Semicircle* turn the Index about till by the sights you see the Tree at A, and there also note what degrees the Index

Index cutteth, which let be
40 deg. 15

Thirdly, Measure the distance
between C and B, which let be
120 Foot; by help of these
three you shall find the distance
of A from either C or B, as fol-
loweth.

Example.

Draw a line upon paper as
A C, and laying the Centre of
your Protractor upon C, and
the Diameter thereof upon the
line C A, with your protracting
Pin make a mark against 140
deg. and through that point and
the point C, draw a line C B;
then from your Scale take 120
Foot, and set it upon the line
C B, from C to B. C This

3d This done, lay the Centre of your Protractor upon the point B, and the Diameter thereof upon the line C B, and make a mark against 40 deg. through which mark and the point B, draw the line B A, cutting the former line C A in the point A.

Lastly, If you take in your Compasses the line C A, and measure it upon the Scale from which you took B C 120 Foot, you will find it to contain 154 Foot and about half a Foot, and such is the distance A C.

3th In like manner, if you measure A B by the same Scale, you shall find it to contain 224 Foot, and about half a Foot.

 PROP. VI.

*How to Measure the Distance
of several Places from you,
as also of one from another,
by measuring only of one
Distance, and observing
of Angles by the Semi-
circle.*

 FIG. III.

L Et A, B, C, D, E, be several places, as Churches in a Town or City, or the like, whose distance you require one from another.

C 2

First,

First, Make choice of two places, from either of which you may see all the places, whose distance you require, which places let be F. and G, distant one from another 100 Foot.

Secondly, Place your Semicircle at F, and laying the Index on the Diameter, turn the Semicircle about till through the sights you see your other place of standing at G; and there fixing your Instrument, first, direct your sights to A, noting what degrees the Index cutteth, then to B, and note what degrees are there cut by the Index, doing the like at C, D, and E; all which degrees note down in a Book or paper.

Then

Then removing your Semicircle to G, and setting up a Mark at F, lay the Index on the Diameter thereof, and turn the Semicircle about till you see the place of your former standing at F, and there fixing the *Semicircle*, make observation of every place as you did at F: First, directing the sights to A, noting the degrees cut by the Index, likewise to B, C, D and E.

By these observations of Angles, made at either station F and G, and the stationary distance, you may draw a perfect draught of all the places upon paper or velem, in their true position and situation, in manner following.

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Example.

First, Upon your velem or paper draw a line F G, containing 100 Foot of any Scale, which line shall represent the distance of your two stations.

Secondly, Place the Centre of your Protractor upon F, and lay the Diameter thereof upon the line F G, and there keeping it steady, make a mark against those deg. which the Index cut upon the *Semicircle* when the sights were directed to A; also make a mark against those deg. of the Protractor which the Index cut at B, & the like at C, D & E.

Thirdly, Through the point F, and every one of those marks you made against the side of
the

the Protractor, draw lines, as
 F A, F B, F C, above the line
 F G, and F D, F E, below the line.

Fourthly, Lay the Centre of
 your Protractor upon the point
 G, and the Diameter thereof
 upon the line F G, and there
 keeping it fast make marks a-
 gainst the edge thereof, at those
 degrees the Index cut, upon the
 Semicircle, when the sights were
 directed to A, B, C, D, and E;
 and through those points and
 the point G, draw right lines
 G A, G B, G C, G D, and G E,
 cutting the former lines drawn
 from F, in the points A, B, C, D,
 and E; which points will stand
 in the same position and situation
 as the Churches or other places
 in the City or Town do; and if

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you take in your Compasses the distance between any two of them, and measure that distance upon the same Scale that FG 100 was measured from, it will there shew you the distance of those two places.

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THE USE
of the
SEMICIRCLE
IN
Measuring of LAND.

PROP. I.

*To take the Plat of a Field
by placing the Semicircle
in any part thereof, from
whence all the Angles of
the Field may be seen.*

Place your Semicircle upon
his staff in some convenient
place of the Field (whose Plat
you would take) that from
C 5. thence

thence you may conveniently see all the Angles thereof, then setting the Semicircle level (by help of the Ball-socket) lay the Index upon the Diameter , and turn the Semicircle about till the Needle hang directly over the North and South Points of the Card, and there fix the Semicircle , by help of the screw of the *plain Socket* , then doth the Instrument (the Diameter thereof) lie directly in the Meridian, and is fitted for your present use.

Your Instrument thus fixed, cause marks to be set up at every angle of the Field (or rather let one go from angle to angle with a long staff having a white cloth or paper tyed to the top thereof) and coming to your
In-

Instrument, the Diameter being next to you, and the Limb of the Semicircle from you, turn the Index about till through the sights thereof you espie the first of your marks (or man) which is on your right hand, and when you have directly found your mark, let the Index rest, and see what degrees and parts of a degree of the Semicircle are cut thereby; which degrees and parts note down in a book or paper ruled, as that which followeth.

In this nature must you deal with every angle, round about the field, beginning at that which is next towards your left hand, and proceeding gradually from that towards the right hand, till you find that end of
the

the Index which cut the degrees falls off of the Instrument, (which will alwayes be when you come past 180 degrees) then must you look through the other sights, and the Limb of the *Semicircle* will be next to you, and you must count your degrees from 180 towards 360; to which, before you come, you will have passed all your Angles.

When you have taken observation of all your Angles, you must, with your Chain, measure from the place where your *Semicircle* stands, to every Angle (beginning with the first, and so proceeding from the left towards the right hand) and note how many Chains and Links each line contains, which lengths must

must be set down in your book or paper, in a column by themselves, against the degrees which the Index cut, when you made observation at that Angle, that is, the first length against the first degrees, and the second length against the second degrees; and in this order must you proceed till you have measured all your lengths.

The foregoing Precepts illustrated by Example.

F I G. IV.

L Et a, b, c, d, e, f, g , be a field to be Surveyed. Place your *Semicircle* (it being a convenient place) at O, the diameter thereof, as also the Needle
in

in the Box, hanging over the North and South Points in the Card, then will they lie directly over the line N S in this Figure; then fix your Instrument, and directing your sights to A (your first Angle) you shall find the Index to cut 12 *d.* 15 *m.* which set down in your book or paper; then directing your sights to B, the Index cuts 37 *d.* at C, 94 *d.* 30 *m.* and the rest as in the following Table, representing your book or paper, in which you took your notes.

	<i>d. m.</i>		C. L.
The Index cut when directed to the mark	A- 12.15	And the distance from O the place of the Semicircle, was	OA - 10.35
	B- 37. 0		OB - 9.45
	C- 94.30		OC - 10.30
	D- 169.15		OD - 6.10
	E- 193. 0		OE - 8.93
	F- 270 30		OF - 8.05
	G 347. 0		OG - 5.20

Having

Having gone through all your Angles, and noted them down in your book or paper, as is done in the foregoing Table, in the column having *d. m.* at the top thereof (signifying Degrees and Minutes) you must then go to the measuring of your lines, where you shall find O A to contain 10 Chains 35 Links, O B 9 Chains 45 Links, and the rest as in the Table in that column which hath C. L. at the top thereof, C signifying Chains, and L Links.

When you have thus taken observation of all your Lines and Angles, and noted them down in a Book or paper, you may, at pleasure, draw the Plat
of

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of the Field upon Velem or
Paper, by the Precepts which
shall be delivered in the follow-
ing Proposition.

PROP.

PROP. II.

*How to lay down the Plat of
the former Field upon Ve-
lem or Paper, by help of
the former Observations
of Lines and Angles.*

UPON a piece of Velem or
sheet of Paper, draw a
line for the Meridian or North
and South Line, represented
by the line in the Figure by N S.
In some convenient place of that
line (as at O) assign a point,
which point O upon your paper,
represents or signifies the place
in the Field where your Semi-
circle

circle stood when you made observation of your Angles.

Upon this point O place the Centre of your Protractor, laying the Meridian Line or Diameter thereof just along the line N S, drawn upon the paper, and there hold it fast. Then having recourse to your Table of Angles, which you observed in the field, you find your first to be 12 deg. 15 min. wherefore, close to the edge of your Protractor, and against 12 deg. 15 min. make a mark with your protracting Pin; and still keeping your protractor in the same position unmoved, make a mark against 37 deg. your second Angle, also against 94 deg. 30 min. your third Angle, and against 169 deg. 15 min. your fourth Angle. Then

Then because your fifth Angle at E, exceeds 180 deg. it being 193 deg. you must turn the *Semicircle* of your *Protractor* downwards, laying the Centre thereof upon the point O, and the Diameter upon the line NS as before, and against 193 deg. make a mark with your *protracting Pin*, do the like against 270 deg. 30 min. your sixth Angle, and against 347 deg. your last Angle.

These points being marked upon your paper, through every one of them, and the point O, draw obscure lines as OA, OB, OC, OD, OE, OF and OG—— Then having recourse to your Table of Lines, which you measured in the Field, you find that the first line OA, contained

tained 10 Chains 35 Links,
 wherefore from some Scale (ac-
 cording to the bigness you
 would have your *Plat*) take 10
 C. 35 L. and set it upon your pa-
 per from O to A, this point A u-
 pon the paper shall represent the
 first Angle in the field A; your
 second length being 9 Ch. 45 Li.
 take that from your Scale, and
 set it upon your paper from O
 to B. Do thus with all the rest
 of the lengths, and when you
 have found out and marked
 upon your paper the several
 points A, B, C, D, E, F and G.
 If you draw lines from point to
 point, as from A to B, from B
 to C, from C to D, &c. you
 shall constitute the figure A B C
 D E F G, which shall be the
 exact *Plat* of your *Field* O.
 And

And thus may you take the *Plas*
of any *Field*, where you may
see all the *Angles* from any one
place.

PROP.

PROP. III.

How to take the Plat of a Field or other piece of Ground, by placing the Semicircle in some one Angle thereof, from whence all the rest may be seen.

YOur *Semicircle* being placed in the Angle where you intend to make your observation, with the Index upon the Diameter thereof, and the Needle hanging over the Meridian Line in the Card. It being thus fixed, direct your sights to the first Angle towards your left hand,

hand, noting the degrees and minutes cut by the Index, and note them down in a book or paper, in all respects as you did those in the former *Proposition*.

Then measure with your Chain from that Angle where your *Semicircle* standeth, to every one of the other Angles, noting the lengths of every of them, and write them also down in your book or paper, proceeding thus from the first line on your left hand, till you come round the field to that again.

Example.

Example.

F I G. V.

L Et H, K L M N O P Q be a piece of Ground to be measured in the manner here prescribed: The *Semicircle* placed in the Angle Q, direct the sights to H, where the Index cuts 15 *deg.* which note down, then direct the sights to K, where the Index cuts 31 *degrees*, 30 *minutes*, likewise to L, M, N, O, P, where the Index cut the *degrees* and parts, as in the Table following.

The

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d.m.

C.L.

n-	H- 15. 0	And the distance from the An- gle Q, as	QH - 9.90
ut	K- 51.30		QK - 10.25
	L- 87.14		QL - 11.60
ted	M-106. 0		QM - 12.30
e	N-168.15		QN - 12. 0
e	O-196. 0		QO - 10.85
	P-250. 0		QP - 6.88

D PROP.

Example.

F I G. V.

L Et H, K L M N O P Q be
 a piece of Ground to be
 measured in the manner here
 prescribed: The *Semicircle* pla-
 ced in the Angle Q, direct the
 sights to H, where the Index cuts
 15 *deg.* which note down, then
 direct the sights to K, where
 the Index cuts 31 *degrees*, 30
minutes, likewise to L, M, N, O, P,
 where the Index cut the *de-*
grees and parts, as in the Table
 following.

The

*d.m.**C.L.*

The Index cut when directed to the Angle	H-	15. 0	And the distance from the An- gle Q, as	QH -	9.90
	K -	51.30		QK -	10.25
	L -	87.14		QL -	11.60
	M -	106. 0		QM -	12.30
	N -	168.15		QN -	12. 0
	O -	196. 0		QO -	10.85
	P -	250. 0		QP -	6.88

D**PROP.**

PROP. IV.

*By the former Observations
of Lines and Angles, to
draw the Plat or Figure
of the Field upon Velem
or Paper.*

DRaw upon Velem or Paper
a line N S, representing
the Meridian Line, upon which
line assign a point as Q, which
denotes the place where your
Semicircle stood in the field.

Upon this point Q, lay the
Centre of your Protractor, and
the Diameter thereof upon the
line N S; and there holding it
fast, look in your Table what
degrees

degrees the Index cut when you made observation at H, which were 15 degrees, make a mark against 15 degrees of your Protractor; likewise see by your Table what *degrees* the Index cut when you made observation at K, which were 31 *degrees* 30 *min.* make a mark against 31 *deg.* 30 *min.* of your Protractor; and in like manner do with every Angle, as at L, 87 *deg.* 15 *min.* at M, 106 *deg.* 0 *min.* at N, 168 *deg.* 15 *min.* at O, 196 *deg.* and at P, 250 *deg.* at all which numbers of *degrees*, make marks against the side of your Protractor.

Then removing your Protractor, draw right lines from the point Q through every one of those marks, so shall you have

upon your velem or paper the several Lines QH, QK, QL, QM, QN, QO, and QP.

Again repair to your former Table, where you shall find that the line QH, being measured by the Chain in the field, contained 9 Chains, 90 Links, take this distance from any of your Scales, and set it upon the line QH, from Q to H; and so have you the point H upon the paper.

In like manner, take 10 Chains 25 Links from your Scale, and set it from Q to K, so have you the point K upon your paper. And in this manner deal with all the numbers of Chains and Links in your Table, and they will give you the points L, M, N, O, P, upon your velem or paper. Lastly,

Lastly, If you draw the lines QH, QK, QL, QM, QN, QO, QP; you shall thereby constitute the true Symetry or proportion of the field you measured, the several Angles whereof are H, K, L, M, N, O, P, and Q.

PROP. V.

How you may by the Semi-circle, take the true Plat of any large piece of Ground, as Park, Wood, Marsh, or other spacious Inclosures, by going round about the same.

IN going round about a field
(or other ground) to survey
D 3 M,

M, which is the most general way of all others, there are two wayes, but both effected by the same artifice ; for in going about a field, you may either go about it on the inside of the field, or on the outside thereof, and sometimes you shall be constrained to go partly within and partly without, and if you go without the field, you may (if you will) take the quantity of the Angles within, and if you go on the inside, you may take the quantity of the Angles without : This I give by way of caution, but the way I intend here, is (as being the best to prevent mistakes) in going without, to take the quantity of the Angles without ; and if within, to take the quantity of the Angles within the field.

Fig.

F I G. V I..

Let A B C D E F be a field
to be measured by going about
the same on the outside.

First, Begin at any Angle
thereof, as A, and there place
your Semicircle, laying the In-
dex upon the Diameter, and tur-
ning it about, direct the sights
to B, there fix the Semicircle,
and turn the Index about, till
through the sights you see the
Angle at F, and there note what
deg the Index cutteth, which you
will find to be 300, for the quan-
tity of the exterior Angle F A H
without the field, or 60 *de*. for the
quantity of the interior Angle

D 4 within

within the field; but (as I said before) going without the field I make use of the exterior or outward Angles: Then measure the side FA , which you shall find to be 10 Chains 25 Links, and the side AB 7 Chains 50 Links; these distances with the quantity of the Angle note down in a book or paper, as you see in the following Table.

Secondly, Remove your Semicircle to B , and laying the Index upon the Diameter, turn the Instrument about, till through the sights you see the place where your Semicircle last stood at A , and then fixing it, turn the Index about till by the sights you see the Angle C , and there note the *degrees* which the Index cutteth, which
here

here are 145 *degrees*, and the distance B C measured is 7 Chains 10 Links; note both the *degrees* and distance down as before.

Thirdly, Carry your Semicircle to C, and placing the Index on the Diameter, look back to B, and there fix the Instrument, then turn the Index about till you see the Angle at D, where the Index cutteth 270 *degrees*, and the distance CD is 5 Chains 85 Links.

Fourthly, Remove the Semicircle to D, and the Index on the Diameter, look back to C, then fix the Semicircle and turn the Index about, till by the sights you see the Angle at E, the Index cutting 263 *degrees*, and the measured distance DE being 7
D 5 Chains,

Chains, note these down in your book or paper.

Fifthly, Place the Semicircle at E, and the Index lying on the Diameter, look back through the sights to D, then fixing the Instrument there, turn the Index about till by the sights you see the Angle F, the Index cutteth *220 degrees*, and the measured distance E F being 10 Chains 70 Links, both which you must note down. And

Sixthly, Carry the Semicircle to F, and the Index lying on the Diameter, look back to E, and then fix the Instrument, then turn the Index about till by the sights you see your first Angle at A, the Index then cutting *210 degrees*; these being noted down will stand as in this Table.

Angles.

	d.	m.	C.	L.	
Angles.	A -- 300	-- 0	10	-- 25	
	B -- 145	-- 0	7	-- 50	
	C -- 270	-- 0	7	-- 10	Sides.
	D -- 263	-- 0	5	-- 85	
	E -- 220	-- 0	7	-- 00	
	F -- 210	-- 0	10	-- 70	

These Observations of Sides and Angles being made in the field, and noted down as in the foregoing Table, a Plat thereof may be drawn upon velem or paper by help of the following directions.

PROP. VI.

*How to draw a true Plat of
the Field before measured,
by help of the Table of
Sides and Angles.*

UPon your velem or paper draw a Line A B, containing 7 Chains 50 Links of any Scale, and upon the end A place the Centre of the *Protractor*, laying the Diameter upon the line A B, then the exterior Angle A being 300 *degrees*, make a mark against 300, and through that point and the point A, draw a line downwards as A F, containing 10 Chains 25 Links.

Secondly, Place the Centre
of

of the *Protractor* upon B, and the Diameter upon A B, and against 145 *degrees* (the Angle at B) make a mark, and through that mark and B draw the line B C, containing 7 Chains 10 Links.

Thirdly, Lay the Centre of the *Protractor* upon C, and the Diameter upon B C, and against 270 *deg.* make a mark, through which, and C, draw the line C D, containing 5 Chains 85 Links.

Fourthly, Lay the Centre of the *Protractor* upon D, and the Diameter upon C D, making a mark against 263 *deg.* through which, and the point D, draw the line D E, to contain 7 Chains.

Lastly, Lay the Centre of
the

the *Protractor* upon E, and its Diameter upon D E, and against 220 *deg.* make a mark, through which, and the point E, draw a right line E F, which will cut your line A F in F; so have you upon your velem or paper, the true figure of your field, A B C D E F.

In all the Work of these two last Propositions, we have wrought by the exterior or outward Angles: If any have a desire to work by the interior or inward Angles, it is but taking the exterior Angle from 360 degrees, and the interior Angle will remain. So the Angle at A being 360 degrees, that taken from 360 degrees, leaves 60 degrees for the interior Angle at A. So B being 145 degrees, that
taken

(63)

taken from 360, leaves 215 for
the interior Angle.

PROP. VII.

*The Plat of a Field being
laid upon paper, and the
Scale by which it was laid
down known, to find how
much the said Field con-
taineth in Acres, Roods,
and Perches.*

THere are several wayes to
effect this; but I shall here
deliver only one, which shall be
general, and that which by all
(or most) Surveyors is practiced.

Every irregular Plat or Fi-
gure, before the quantity or
con-

content of it can be found, must first be reduced into such Regular Figures, for the mensuration whereof there are certain Rules: The most meet and convenient figures into which Irregular Plats may be reduced are Triangles and Quadrilaterals, called Trapezias, which is done by drawing of lines from Angle to Angle crosse the Plat. And here Note, That of how many sides soever your Plat consisteth, into so many Triangles, wanting two, will the Plat be reduced, and no less, as the Figure VII denotes, where the Plat consisteth of 7 sides, and it is reduced into 5 Triangles.

*The manner of reducing the Plat
into Triangles.*

F I G. VII.

L Et the figure A B C D E F G be a *Plat* which contains seven sides ; to reduce which into Quadrilaterals and Triangles, do thus :

First, Draw the line B F, so is part of the *Plat* reduced into the Quadrilateral A B F G.

Secondly, Draw the line F D, so is another part of the *Plat* reduced into the Trapezia B C D F ; and the other part of the *Plat* is comprehended in the Triangle F D E.

Thus the whole Plat being reduced contains two Trapezias,
viz.

viz. K and L, and the Triangle M, in number five (for every Trapezia contains two Triangles) which are less by two than the number of sides.

To cast up the Quantity or Content of the Plat.

First begin with the Triangle M, whose base, F B, is 13. 75. that is 13 Chains 75 Links, and his perpendicular E Q 7 Chains 12 Links.

Now the Quantity, Area, or Content of every Triangle, is found, By multiplying the length of the base by half the length of the perpendicular.

So here the base 13. 75. and the perpendicular 7. 12. the half whereof is 3. 56. if you multiply

(67)

tiply 13.75. by 3.56. (as if they were whole numbers, though in reality the 75 and 56 are Fractions) the product will be 4.89500, and that is the Quantity of the Triangle FDE.

$$\begin{array}{r} 13.75 \\ 3.56 \\ \hline 8250 \\ 6875 \\ 4125 \\ \hline 489500 \end{array}$$

Secondly, For the Trapezia or Quadrilateral L, in which Trapezia you may see that the line CF is a common base to the two Triangles BFC, and CDF, for the perpendiculars BP, and DO, of both Triangles, fall upon it.

Now the Quantity of any Trapezia is found, *By multiplying the common base (here FC) by half the Sum of the two perpendiculars.*

(68)

lars which fall upon it (here B P, and D O.)

So in this Trapezia, the common base C F, is 14 Cha. 90 Lin. and the sum of the two perpendiculars B P, and D O, is 13 Chains 80 Links, the half whereof, is 6.90. If you multiply 14. 90. by 6. 90. the product will be 10.28100.

$$\begin{array}{r} 14.90 \\ \times 6.90 \\ \hline 134100 \\ 8940 \\ \hline 1028100 \end{array}$$

Thirdly, For the Trapezia K, multiply 12.66. (the length of the base B G) by 4.55 half the sum of the two perpendiculars A H and F R, the product of that multiplication will be

$$\begin{array}{r} 12.66 \\ \times 4.55 \\ \hline 6330 \\ 6330 \\ 5064 \\ \hline 576030 \end{array}$$

be.

(69)

be 5.76030, which is the Quantity, Area, or Content of the Trapezia K.

Thus have you the Content of the two Trapezias and the Triangle. Now,

To find the Quantity of the whole Field, in Acres, Roods, and Perches.

Add the products of the several multiplications together, the sum of them is the whole Quantity. So

The	{	Triangle M	}	contai-	{	4.89500	
		Trapezia K				ning	5.76030
		Trapezia L					10.28100

Their Sum is — 20.93630

Which

(70)

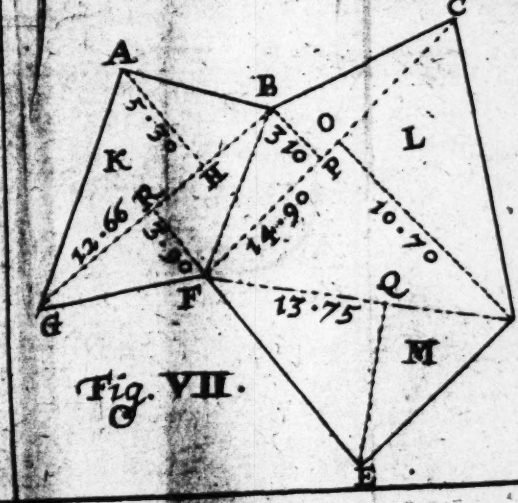
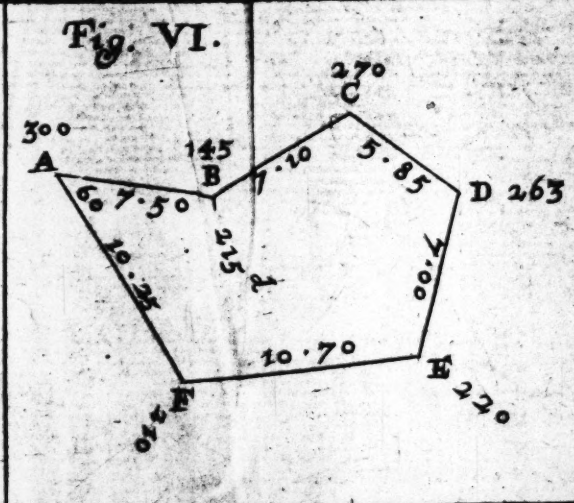
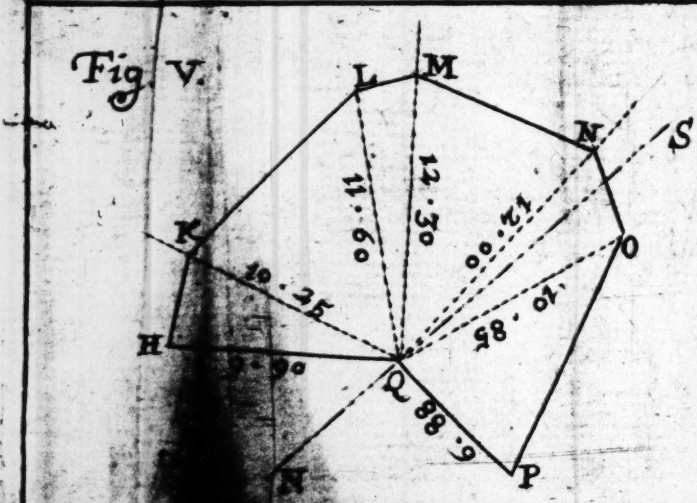
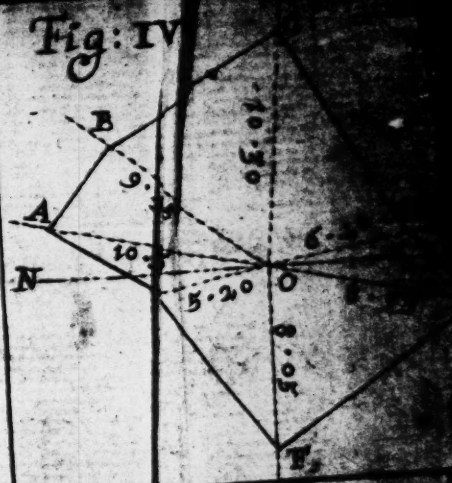
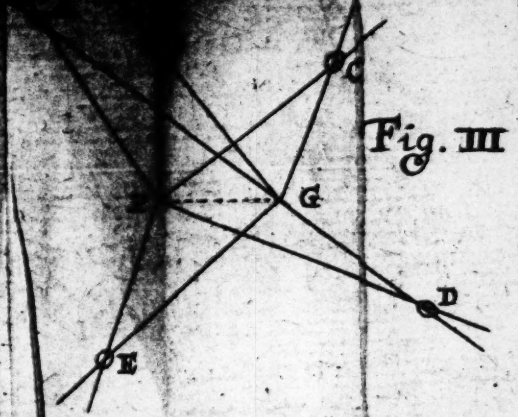
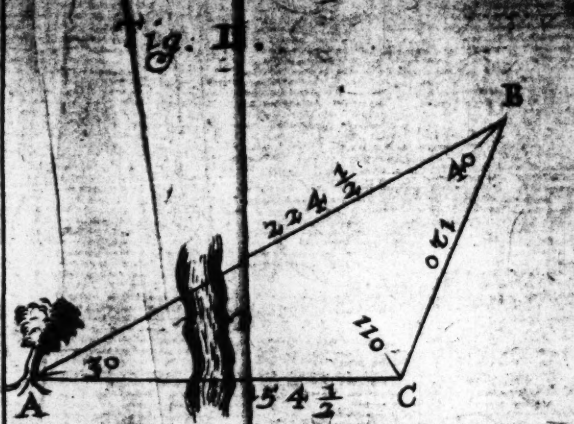
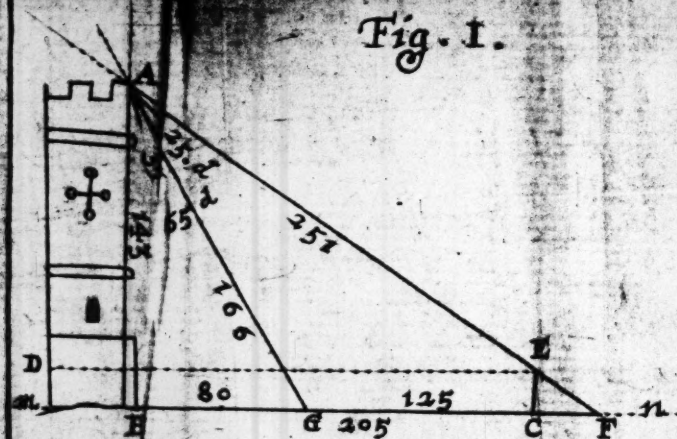
Which is 20 complete or entire Acres, and $\frac{93630}{160000}$ parts of an Acre; and to know how much that is, multiply 93630 by 4 (because 4 Roods make an Acre) the product is 3 complete, and $\frac{74520}{160000}$ parts of a Rood; and to know how much that is, multiply 74520 by 40 (because 40 Perches are contained in one Rood) the product will be 29.80800, which is 29 complete Perches, and $\frac{80800}{160000}$ parts of a Perch, which is inconsiderable, for 160 whole Perches make but one Acre.

Thus have you the Area, Quantity, or Content of this Field cast up, and you find it to

(71)

to contain 20 Acres, 3 Roods
and 29 Perches. And in this
manner may you cast up the
quantity of any Irregular Plat
whatsoever, remembring that
in all your Multiplications you
cut off 5 figures towards your
right hand with a prick of your
pen, as in this Work I have done
all along.

F I N I S.



Place this at the end
of the Booke.
Soe that it
may lye out
when the Booke
is shut.